EMPOWERING PEOPLE AND TRANSFORMING MARKETS

VILLAGE POWER 2000

The World Bank, Washington, D.C.
December 4-8, 2000

DISTRIBUTED POWER FOR RURAL ELECTRIFICATION FROM GEOTHERMAL AND BIOMASS

by

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ORMAT International, Inc.

P27

1946

ORMAT ENERGY CONVERSION TECHNOLOGY

for Biomass and Geothermal Energy for Rural Electrification and Distributed Power

1. Installed geothermal capacity and potential
2. Worldwide distribution of geothermal energy
3. Geothermal technologies
4. Present and Projected future costs of renewable energy
5. Geothermal energy: economical without subsidies
6. ORMAT experience:
   Green before it was “fashinable”
   Mature technology and dependable equipment
   Applications – electricity from geothermal, biomass and solar
   ORMAT geothermal power plants in developed and developing countries
7. Case history: the grid connected ZUNIL Geothermal Project
8. The project and the financial structure
9. Lessons from a Private-Public partnership: project hurdles and opportunities

Installed Geothermal Capacity (~8,000 MWe)(**) and Worldwide Potential* (~60,000 MWe)(*)

COUNTRY	INSTALLED ELECTRICAL GENERATION CAPACITY MWe	POTENTIAL FOR ELECTRICAL GENERATION MWe
USA	2,300	12,000
The Philippines	1,900	6,000
Mexico	850	1,500
Canada	--	250
South & Central America	360	2,000
Western Europe, incl. Iceland	970	1,200
Other European countries	40	500
Indonesia	590	16,000
Japan	550	2,400
P. R. China	30	6,700
New Zealand	440	1,200
Africa, incl. Kenya	60	6,500
Others	10	3,700

* Hot Fractured Rock Excluded

* * As of August 2000

SOURCE: US DOE and World Geothermal Congress 2000

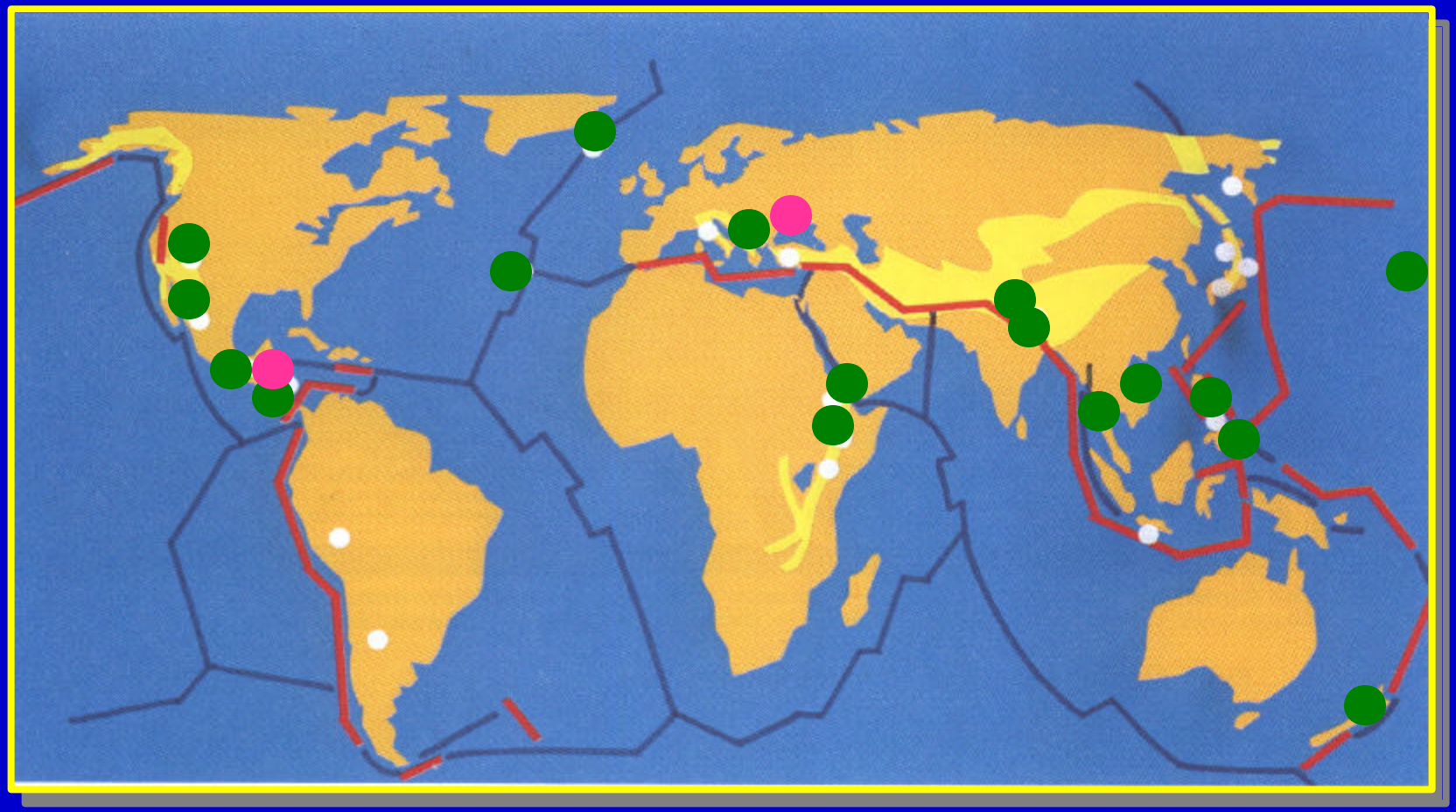
Direct Use of Geothermal Energy (17,000 MWt)

CONTINENT/COUNTRY	DIRECT USE INSTALLED CAPACITY (Mt)
AFRICA	121
AMERICA	5,954
• USA	5,366
• Mexico	164
ASIA	5,151
• China	2,814
• Japan	1,159
EUROPE	5,568
• Iceland	1,469
• Turkey	820
• Georgia	250
• Russia	307
• France	326
• Hungary	391
• Sweden	377
• Italy	326
• Romania	152
• Switzerland	547
OCEANIA	318
• New Zealand	308

SOURCE: World Geothermal Congress 2000 & I. B. Friedleifsoon

1. RESOURCE DISTRIBUTION

Worldwide Geothermal Energy Distribution



Areas where Geothermal Projects are in Operation or Planned

Geothermal areas where ORMAT plants are in operation

Geothermal areas where ORMAT plants are planned

2. TECHNOLOGY

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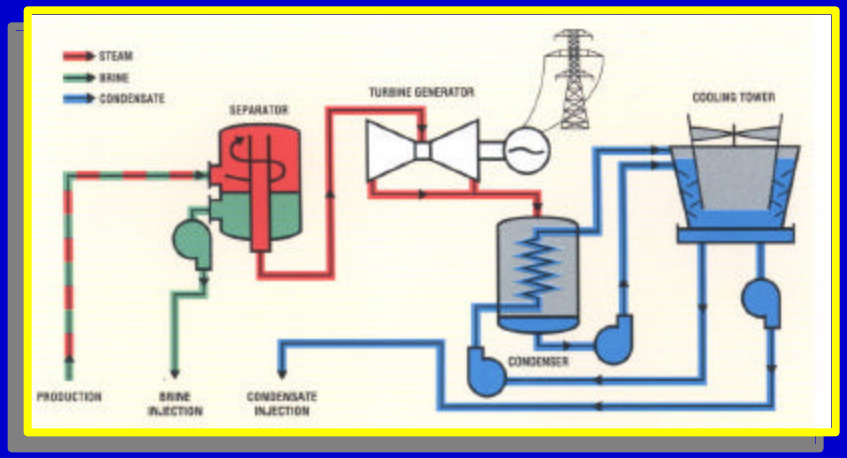
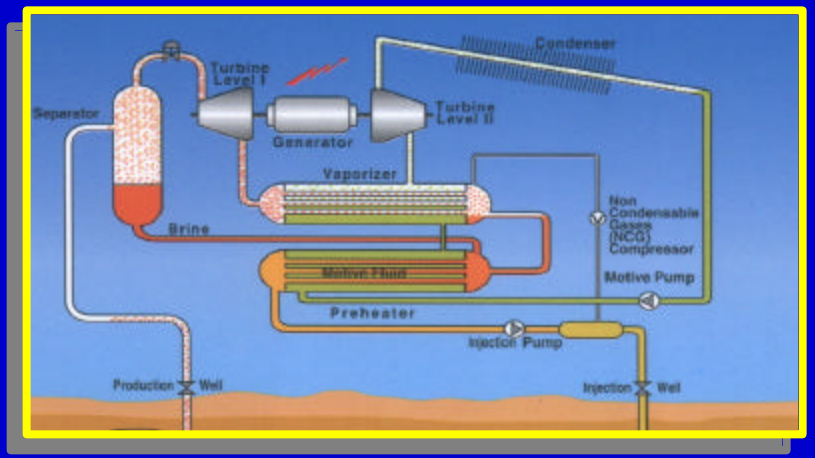
Conventional Geothermal Steam Power Plant



- Consumes Water:
  Aquifer Depletion, Power reduction
- Effluents or Expensive Abatement
- Plume
- Visual Impact
- Water Treatment Needed:
  Use and Disposal of Chemicals

ORMAT Geothermal Power Plant



- All Fluids Reinjected:
  Sustainable, No Power Reduction
- No Emissions (No Abatement Needed)
- No Plume (Air Cooled Condensers)
- Low Profile
- Not Sensitive to Quality of Brine & Steam

3. COSTS

Average Capital and Delivered Costs

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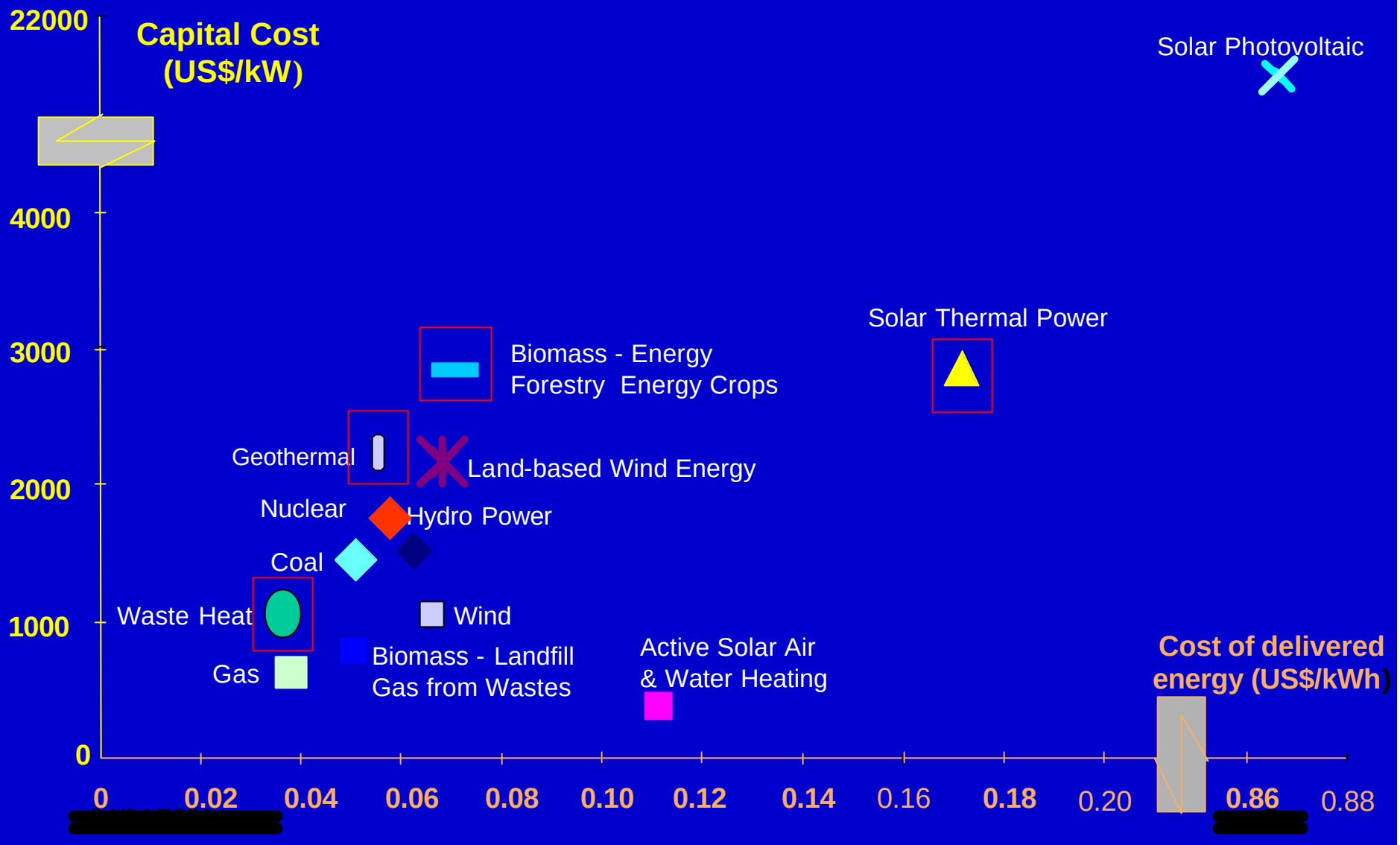
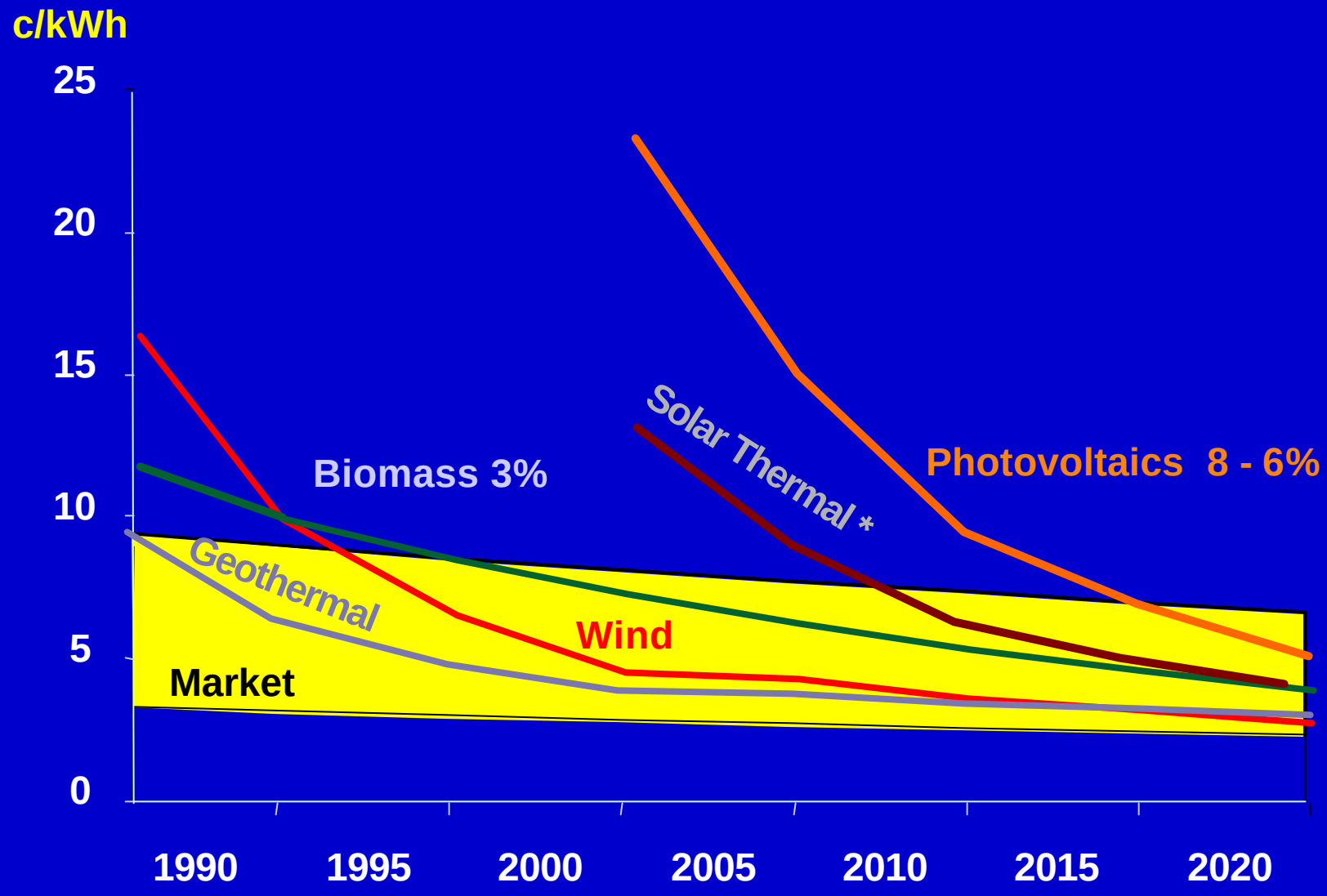


SOURCE: SHELL and DOE

ORMAT

Future Cost of Electricity



Source: SHELL INTERNATIONAL RENEWABLES, ORMAT and BOEING

1950

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GEOTHERMAL ENERGY:

It Is Economically Feasible Without Subsidies and It Makes Business

1. Geothermal Energy can supply a very significant portion of new electrical for islands and many remote areas in developing countries

2. Geothermal Energy on a commercial scale is now competitive with fossil fuels in many areas

3. Geothermal plants can supply grid connected power or power for minigrids

4. Geothermal power is sustainable, saves import and transport of fuels, avoids emissions and contributes to the Economic Development of rural areas

5. Geothermal projects of sufficient scale, or bundles or smaller projects, can be privately financed, without subsidies provided there is institutional support and public political risk insurance

Green Before it was Fashionable

Solar Water Pumping System of 40 m^3/day

5. ORMAT EXPERIENCE: A MATURE TECHNOLOGY

Distributed Renewable Energy and Resource Recovery

700 MW of ORMAT Power Plants in operation in 20 countries

During the last decade, ORMAT's power plants have already avoided the emission of **12 million tons of CO_2** and **saved 4 million tons of fuel**

Geothermal, Heat Recovery, Biomass, and Solar

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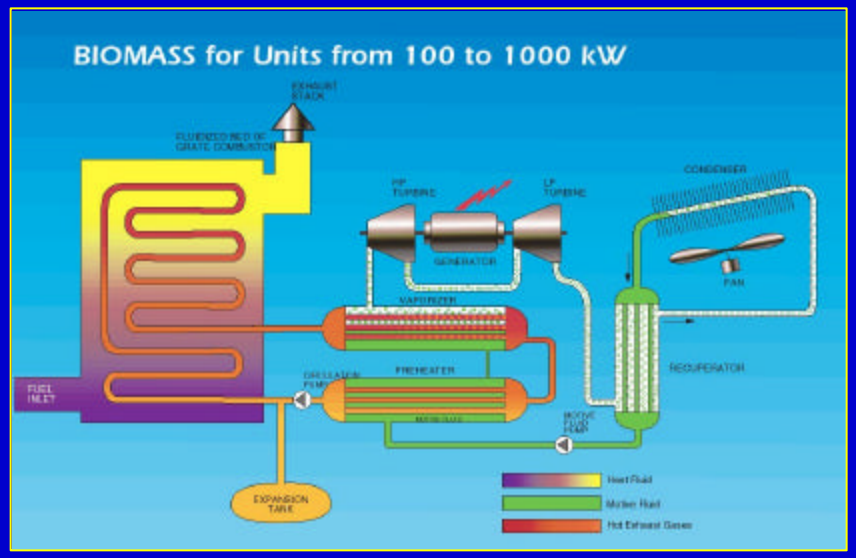
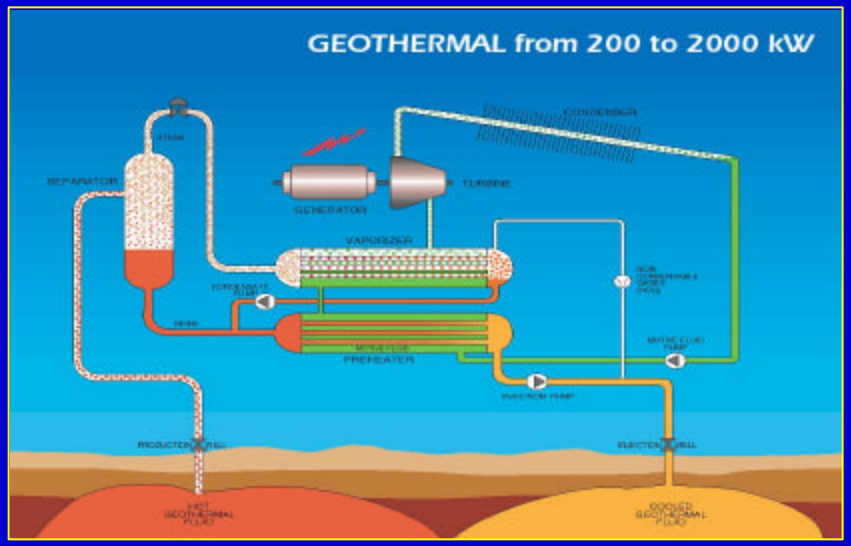
ORMAT ENERGY CONVERSION TECHNOLOGY

for Locally Available Low Grade Heat

Advantages

- **FLEXIBILITY:** heat supply can be any locally available low grade heat
- **LOW MAINTENANCE**
- **SIMPLICITY OF OPERATION**
- **LONG LIFE**
- **INSENSIBILITY TO IMPURITIES:** in the heat source





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Applications of

ORMAT Energy Conversion Technology

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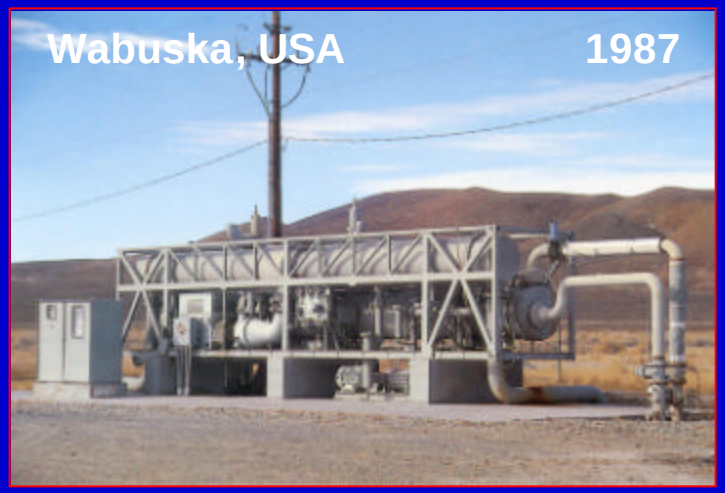
GEOTHERMAL



SOLAR

BIOMASS

WASTE HEAT

1953

APPLICATIONS

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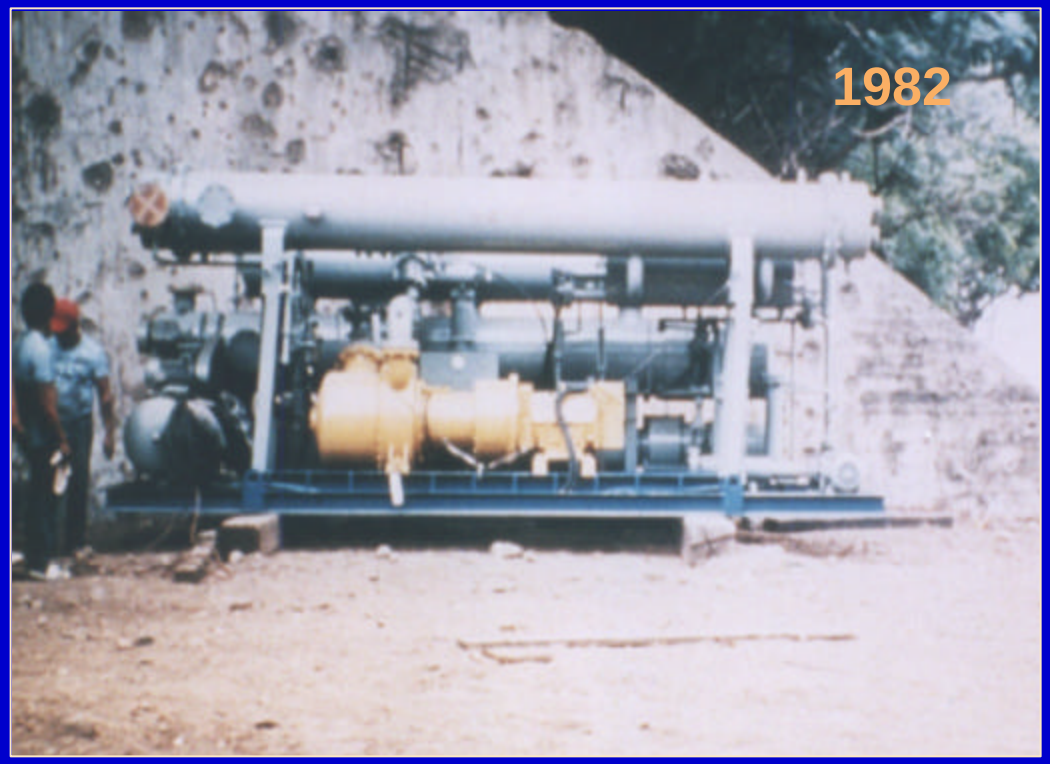
Direct Combustion of Biomass



Corregidor Island, the Philippines

Gas from Manure Digestor

Yagur, Israel

1954

APPLICATIONS

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5 MW ORMAT Solar Pond Power Plant at the Dead Sea

Solar pond area 250,000m^2, depth 3 to 5 m., maximum bottom temp. 102°C

70 kW ORMAT Solar Pond Power Unit El Paso, Texas US only solar pond

1955

ORMAT Geothermal Power Plants

In Developed Countries

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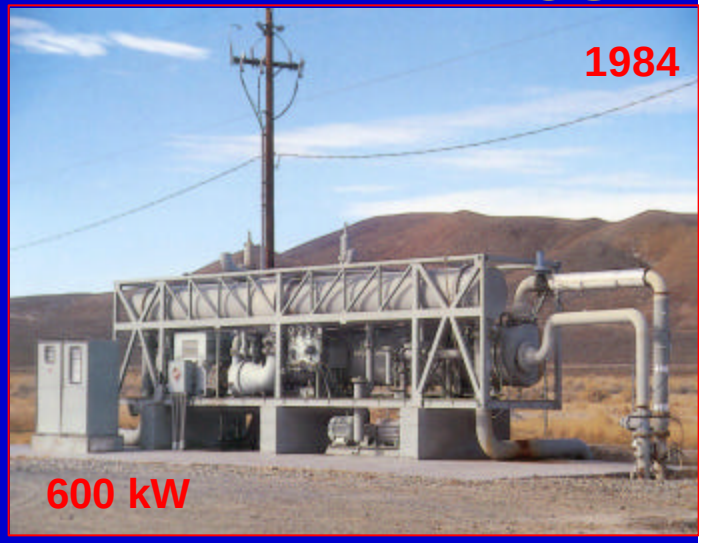
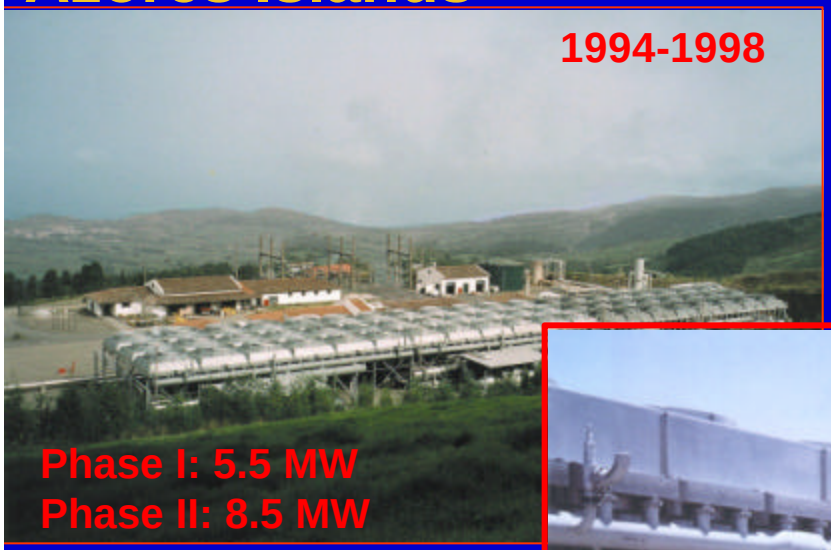
USA



Wabuska Power Plant

Azores Islands

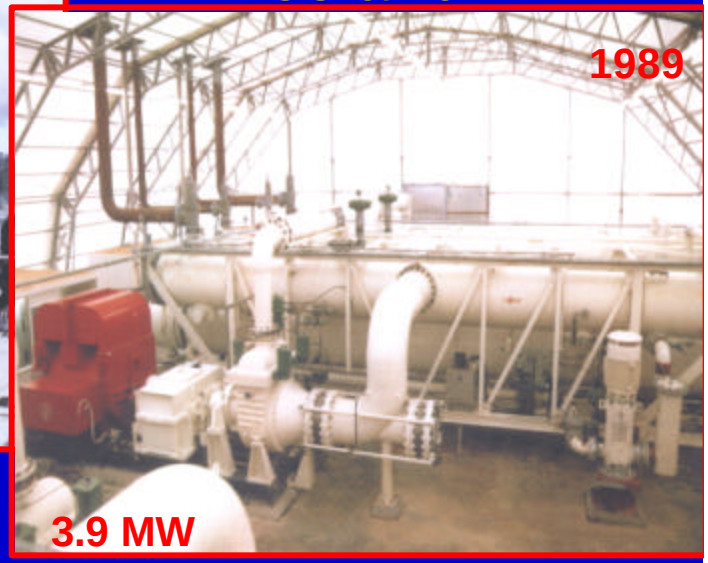


Sao Miguel Power Plant

New Zealand

Bay of Plenty Power Plant

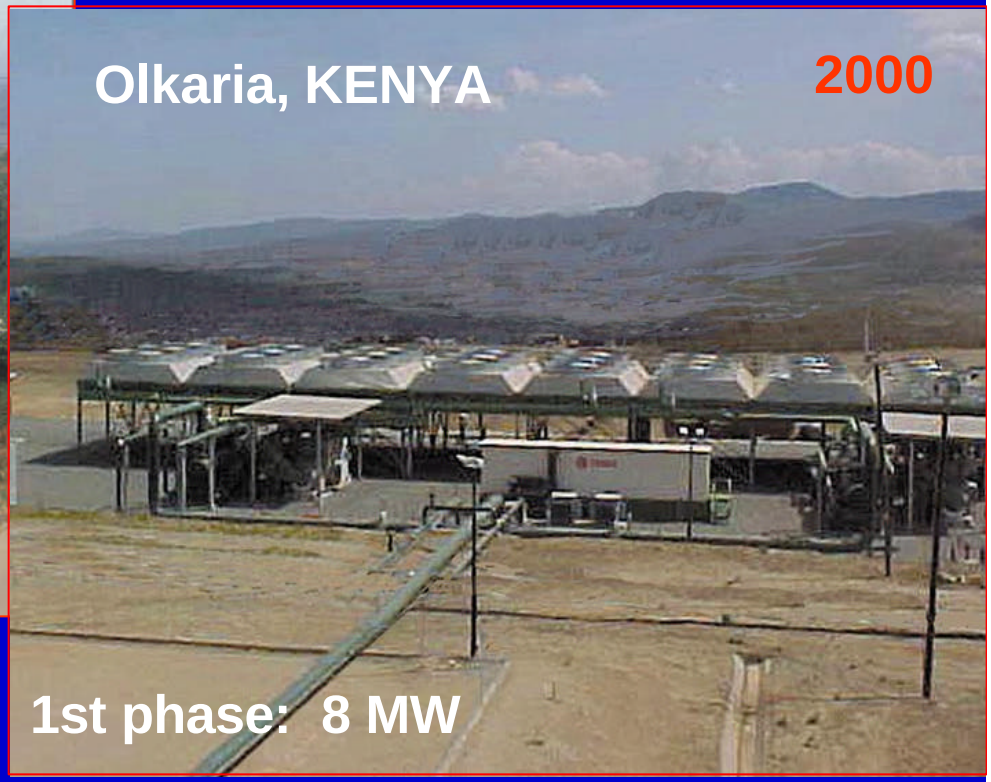
Iceland



Svartsengi Power Plant

1955

ORMAT Modular Geothermal Power Plants
In Developing Countries



Financing: Equity ORMAT 80% ,
EPDCI (Japan) 10% & Itochu 10%
Term Loan: US Exim Bank

Financing: all equity by ORMAT
Insurance: MIGA

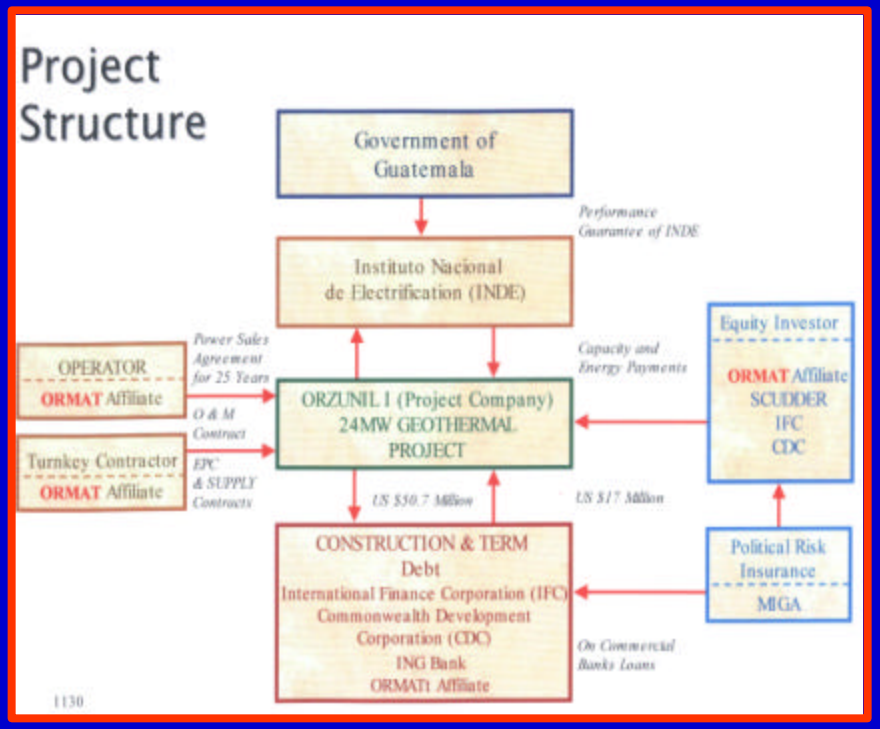
1957

CASE HISTORY:
Grid Connected Zunil Geothermal Power Plant

Project Overview:

- INDE of Guatemala with IADB funds, drilled the production/injection wells through 1992 in Zunil County
- The competitive bid was issued by INDE in 1994 for the power plant at Zunil
- In international competition, ORMAT was awarded the 24 MW BOO project based on a $0.055kWh 15 year PPA in Guatemala
- The plant, in commercial operation since mid 1999, uses 7 ORMAT Energy Converters along with the existing wells
- Guatemala may have up to 500 MW geothermal reserves

CASE HISTORY:
Financial Structure of the ZUNIL Project



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LESSONS FROM PUBLIC-PRIVATE PARNERSHIP PROJECTS

In Developing Countries

Project Hurdles

- Commercial and financial barriers
- Credit issue barriers
- Institutional barriers
- Power legislation barriers: changes after contract signature such as dispatchability
- Standards, specifications and lengthy and costly reviews:
  - Fixed soft costs disproportionate to small project size
  - Micro-management of the project rather than enforcement of specifications

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Project Opportunities

- Accelerating renewable energy deployment by public-private partnership

Public Sector Role:

Now:

1. Subscribe to political risks, streamline and unify procedures
2. Assure correct and stable institutional framework
3. Assist developing countries in assessing local & rural needs
4. Provide performance specification

Future:

1. Reduce subsidies for fuel and unnecessary grid
2. Level the playing field: internalize renewable external benefits or use market mechanism for carbon trading

Private Sector Role:

1. Provide all or part of equity investment
2. Provide the construction loans
3. Guaranty specifications performance and electricity prices
4. Provide technology transfer, O&M training and supervision

FOR MORE INFORMATION…

- **Village Power 2000 CD-Rom**
- **ORMAT Web Site: www.ormat.com**